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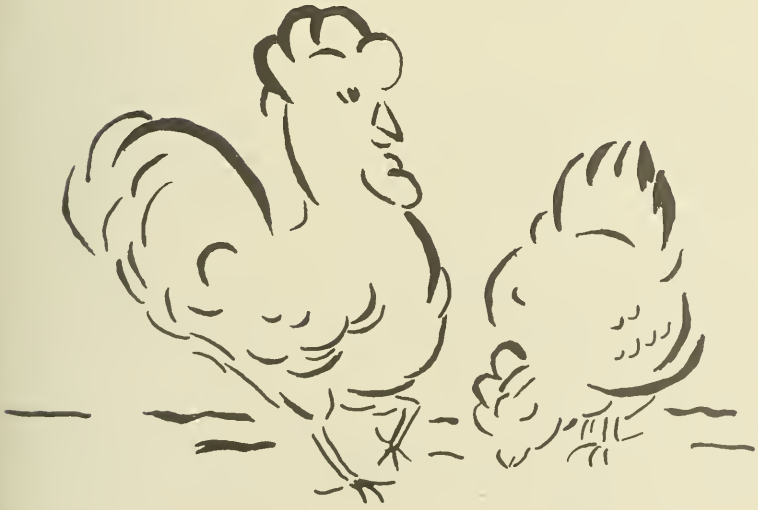
West Virginia Limestone--

A

Calcium Supplement



For Poultry

WEST VIRGINIA UNIVERSITY
AGRICULTURAL EXPERIMENT STATION

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WEST VIRGINIA LIMESTONE--

A CALCIUM SUPPLEMENT FOR POULTRY

T. B. Clark, H. M. Hyre, C. E. Weakley, Jr., and A. H. VanLandingham

West Virginia has plenty of limestone that might be suitable for poultry feeding if properly sized.

Much of this limestone contains less than 90 per cent of calcium carbonate. In the light of some experimental work the feeding value of this limestone might be questioned. West Virginia poultrymen have other arguments against its use. Some believe that hens do not readily consume the native dull-gray limestone. These poultrymen believe that the hens prefer the white, shiny calcitic limestone, an imported product. They also think that native limestone produces egg shells that are rough and sometimes weak. For many years poultrymen have preferred to feed oyster or other marine shells to their chickens. During World War II, however, the scarcity of such shells forced the use of calcitic limestone and some dull-gray limestone. Although calcitic limestone was found to be a satisfactory substitute, many poultrymen are still skeptical about the use of native dull-gray limestone.

Most of the published experimental work shows that crushed limestone containing 90 per cent or more of calcium carbonate is satisfactory for egg production. On the other hand, feeding of very low-calcium limestones did, in most experiments, result in a lower egg production compared with that obtained from high-calcium limestones. In some cases the health of the birds fed dolomitic limestones was impaired. None of the experiments reported in the literature gave sufficient evidence that high-grade limestone produces poor shell quality, but several indicated that the dolomitic limestones reduced shell strength.

Of particular interest to West Virginia poultrymen is an experiment reported by Waite (1935) of the Maryland Experiment Station. In this experiment a blue limestone quarried at Morgantown, West Virginia, was compared with oyster shells. Egg production and shell

strength were similar in all lots, but the birds consumed more oyster shells than limestone. This investigator found that hens usually ate more of the oyster shells than they needed. They expelled that portion not required for egg-shell formation with the droppings. This appears to answer the question that has puzzled experimenters as to how hens can maintain egg production on a lesser consumption of limestone than of oyster shells. Waite stated that the manufacturer of the blue limestone was forced to remove it from the market because poultrymen complained that the layers would not consume enough of this dark-colored limestone.

The arguments against use of dull-gray limestone by West Virginia poultrymen did not seem to be supported by much experimental evidence. However, there was no first-hand information available on the value of native limestone. Although other experiment stations were recommending limestone containing 90 per cent or more of calcium carbonate, much of that quarried in West Virginia contained less than 90 per cent and was considered to be of questionable value as a calcium supplement for poultry feeding. In addition, there was some confusion in the minds of poultrymen concerning the value of grit because crushed limestone is commonly called limestone grit.

EXPERIMENTAL RESULTS FROM LAYING TRIALS

Procedure. The laying trials were started in 1945. New Hampshire pullets were used. In the two following years, both New Hampshire and White Leghorn pullets were used. These trials were conducted in a long-type laying house divided into pens, 20 by 20 feet. Conditions were alike for all pens. The New Hampshire pullets were divided into four groups according to strain and body weight for the first two years and to dam and body weight for the third year. The Leghorn pullets were divided according to dam, body weight, and date of hatch for both years.

The 1945-46 New Hampshire pullets were fed an all-mash ration containing whole oats. In the two following years a 20 per cent protein mash was fed to both breeds of pullets. Scratch grain composed of corn, wheat, and oats were fed to the pullets in measured amounts the grain was fed so that the pullets consumed 40 per cent of corn and wheat to 60 per cent of oats. The total amount of grain fed was based on the amount of mash consumed the previous day. The pullets were forced to consume the ration in the proportion of 40 parts of grain to 60 parts of mash.

The limestone was obtained from quarries in Monongalia and Berk

eley counties. Grade 12A was used, 100 per cent of which passes through a 3/8 inch screen, 95 per cent through a 1/4 inch screen, and 20 per cent passes through a 1/8 inch screen. There is some fine material in this grade that laying chickens will refuse, but not enough to be a serious problem. The calcium carbonate content was about 35 and 90 per cent for the Monongalia and Berkeley County limestones, respectively. The calcitic limestone was No. 3, the size commonly used for adult chickens. It was quarried in Maryland and purchased on the open market in West Virginia.

A statistical analysis was made of all data summarized in the tables.

EGG PRODUCTION

Native Limestone vs. Oyster Shells and Calcitic Limestone. In all laying trials the egg records were not considered until the pullets had been on the treatments for one experimental period. The number of pullets that were started, the number that died, and the weights are given in Table 1. The pertinent data on egg production and feed consumption are given in Table 2 and Table 3 for the New Hampshire and White Leghorns, respectively.

The two native limestones studied were compared with oyster shells and calcitic limestone in 1945-46 (Table 2). This trial was conducted for six, 28 day periods. Lots 1 and 3, fed the native limestones, averaged to lay about the same number of eggs, but these averages were lower than those for Lots 2 and 4. The differences are highly significant. These real differences suggest that the limestones used were inferior to the other calcium supplements. Certainly the differences were not caused by the layers refusing to eat these limestones. The layers in Lots 1 and 3 ate more limestone per period or per dozen eggs than did those fed oyster shells or calcitic limestone. These results could have been influenced by other conditions, as suggested in a later experiment with this breed. It should be remembered that the pullets used in these trials were not pedigreed according to dam and may not have been uniformly distributed. Furthermore, the treatments were not replicated. Too, the consumption of limestone may have been excessive.

The 1946-47 trial with White Leghorns, Table 3, was conducted to provide a more critical comparison of native limestone containing about 90 per cent calcium carbonate with oyster shells. Four lots of pedigreed White Leghorns were used. The lots were paired so that each pair contained pullets from the same dam. Each dam's offspring

Table 1. Number of pullets, the mortality, and their average body weights.

Lot	Supplement	Number of Pullets		Av. Body Weight	
		Started	Died	Initial	Final
	New Hampshires – 1945–46				
1	Limestone (90%)	90	12	5.7	5.8
2	Oyster Shells	87	10	5.7	5.8
3	Limestone (85%)	95	13	5.9	5.8
4	Calcitic Limestone	33	14	5.8	5.8
	New Hampshires – 1946–47				
5	Limestone (85%)	92	11	5.5	6.1
6	Limestone (85%) and Granite Grit	92	9	5.5	6.0
7	Oyster Shells	90	9	5.5	5.8
8	Oyster Shells and Granite Grit	88	0	5.4	5.7
	New Hampshires – 1947–48				
9	Limestone (85%)	87	4	4.8	5.9
10	Limestone (85%) and Granite Grit	88	7	4.9	5.9
11	Limestone (85%)	88	5	5.0	5.6
12	Limestone (85%) and Granite Grit	88	8	4.8	5.8
	White Leghorns – 1946–47				
13	Oyster Shells	111	16	3.8	4.1
14	Limestone (90%)	113	16	3.7	4.0
15	Oyster Shells	114	12	3.7	3.8
16	Limestone (90%)	114	10	3.7	3.9
	White Leghorns – 1947–48				
17	Oyster Shells	115	7	3.8	3.8
18	Limestone (85%)	115	13	3.7	3.8
19	Oyster Shells	115	7	3.8	4.0
20	Limestone (85%)	115	4	3.8	3.9

were distributed between each pair of lots according to body weight a date of hatch. Except for the different calcium supplements, all l were fed and managed alike.

The average egg production values for each pair of lots are almo identical. Egg production values for Lots 13 and 14 are higher th those for Lots 15 and 16. The only explanation for this seems to the age difference. The first two lots contain pullets from the ea hatches.

The 1947-48 trial with White Leghorns, Table 3, was conducted provide more information on a local limestone containing about 85 p cent calcium carbonate. The pullets were distributed between the f

Table 2. Results from New Hampshire pullets showing feed and calcium supplements consumed, and egg production values when fed different calcium supplements with and without grit.

Lot	Calcium Supplement	Av. Feed Consumed		Av. Supplement Consumed		Egg Production	
		Per Period (pounds)	Per Doz. Eggs (pounds)	Per Period (pounds)	Per Doz. Eggs (pounds)	Per cent	Per Hen
		December 24, 1945 to June 9, 1946*					
1	Limestone (90%)	9.41	7.52	.47	.37	59.11	99.3
2	Oyster Shells	9.63	6.93	.40	.29	65.81	110.6
3	Limestone (85%)	9.44	7.47	.45	.36	59.54	100.6
4	Calcitic Limestone	9.87	7.18	.42	.30	66.00	110.9
		November 25, 1946 to June 8, 1947*					
5	Limestone (85%)	9.08	6.38	.44	.31	60.97	119.5
6	Limestone (85%)			.34	.22		
	and Granite Grit	9.41	6.16	.39	.25	65.58	128.5
7	Oyster Shells	8.69	6.59	.25	.19	56.76	111.2
				.23	.17		
8	Oyster Shells and Granite Grit	8.81	6.32	.41	.29	59.88	117.4
		November 10, 1947 to June 13, 1948*					
9	Limestone (85%)	8.99	5.45	.43	.26	71.12	159.3
10	Limestone (85%)			.28	.19		
	and Granite Grit	8.92	5.95	.11	.08	64.35	144.1
11	Limestone (85%)	8.86	5.52	.46	.29	68.20	152.8
12	Limestone (85%)			.33	.20		
	and Granite Grit	8.84	5.47	.11	.07	68.47	153.4

* The length of the experimental period for each of the three successive years was 6, 7, and 8, 28-day periods, respectively.

Table 3. Comparison of oyster shells, limestone when fed to White Leghorn pullets as calcium supplements.

Lot	Calcium Supplement	Av. Feed Consumed		Av. Supplement Consumed		Egg Production	
		Per Month (pounds)	Per Doz. Eggs (pounds)	Per Month (pounds)	Per Doz. Eggs	Per cent	Per Hen
		December 1, 1946 to July 31, 1947*					
13	Oyster Shells	8.11	4.97	.44	.27	65.17	158.4
14	Limestone (90%)	8.15	4.99	.59	.36	65.25	158.6
15	Oyster Shells	7.88	5.05	.52	.33	62.27	151.3
16	Limestone (90%)	7.87	5.09	.62	.39	61.76	150.0
		December 1, 1947 to June 30, 1948*					
17	Oyster Shells	8.57	4.85	.45	.25	67.67	142.3
18	Limestone (85%)	8.77	4.74	.57	.31	67.48	142.2
19	Oyster Shells	8.52	4.85	.44	.25	67.16	141.3
20	Limestone (85%)	8.26	4.73	.54	.31	67.42	142.0

* The length of the experimental period for each of the two successive years was 8 and 7 months, respectively.

lots according to dam, pedigree, and hatch. Results of this trial show that egg production for all lots was alike. The pullets laid as many eggs when fed native limestone containing 85 per cent calcium carbonate as they did when fed oyster shells. The egg production values are remarkably uniform. The difference in egg production between the two years is due largely to a shorter experimental period of seven months in the latter year compared with eight months in the former year.

The Effect of Grit. Calcitic limestone often is considered to function in the dual capacity of furnishing calcium and acting as a grinding agent. Of course, it breaks down more readily than a granite grit or river pebbles. Nevertheless, it was of interest to determine if the native limestones would serve reasonably well for both purposes. To obtain this information a series of trials were started. The 1946-47 trial with New Hampshire pullets was conducted to compare native limestone and oyster shells with and without granite. Both supplements were kept continuously before the pullets.

Results in Table 2 show that the pullets with access to grit (Lots 6 and 8) laid significantly more eggs than those without grit (Lots 5 and 7). Also, the lots fed the limestone laid significantly more eggs than those fed oyster shells. The higher egg-producing lots proved to be more efficient in the utilization of feed on a per-dozen basis.

The pullets that had access to granite grit ate large quantities of it. In fact, they ate more grit than they did oyster shells or limestone. This surprising result might have been caused by a deficiency in the diet or by the hens' inability to differentiate between these calcium supplements and the granite grit. However, the granite grit may have been more attractive. Other workers have reported that certain colors are attractive in grit, especially black specks.

Even though the pullets fed the granite grit laid more eggs than those without this grit, its economic value still is open to question. The pullets ate such large quantities of the grit so that the additional eggs laid just increased the returns enough to slightly more than pay for the grit. To have any value when fed with West Virginia limestone, granite grit should increase annual egg production more than 5 per cent. This is based on the prices at the time of this experiment.

One interesting result is that regardless of whether or not grit was fed, the lots fed limestone laid more eggs than those fed the oyster shell. Furthermore, the higher production was obtained from the 85 per cent limestone. This is strong evidence that such limestone produces satisfactory egg production. This trial also indicated that the Leghorns utilized the limestone no better than did the New Hampshires.

The 1947-48 trials with New Hampshires were conducted to obtain more information on the value of grit. The pullets had eaten larger quantities of grit in the previous trial than seemed to be justified. Since the actual grit requirements were shown by Waite (1935) to be lower than obtained here, it seemed advisable to restrict the grit. Accordingly, trials were set up using the same treatments as in 1946-47. The granite grit fed was restricted by opening the grit hoppers only one day each week. Each treatment was replicated, and the pullets were distributed according to dam, pedigree, and hatch.

Results of the 1946-48 trials, given in Table 2, suggest that the feeding of granite grit one day each week had little or no effect on egg production. In fact, Lot 9, which did not receive granite grit, laid more eggs than did Lot 10, which had access to grit one day per week. This is opposite of the results obtained in the previous year. In the other pair of pens the egg production values are almost alike. It is believed that the egg production in Lots 9 and 10 may have been affected by something other than granite grit.

SHELL QUALITY

Several methods were compared to study the effects of various calcium supplements on shell quality. During the first year a shock test and the percentage moisture loss methods were used. These were not found to be critical enough, so three other methods were studied during the laying year, 1947-48. They were (1) shell thickness, (2) shell strength as indicated by a puncture method, and (3) the specific gravity of the whole egg. The values obtained from either of the first two methods were found to be highly correlated with those of the third method. Actually, specific gravity measures shell density and is a good indicator of shell quality. The specific gravity test was found to be the best practical method for measuring differences in shell quality. It was the easiest test to manipulate, and the eggs could be marketed afterwards. Only the results from this test are reported here.

RESULTS FROM SPECIFIC GRAVITY TESTS

Table 4 gives the specific gravity values. The results for the White Leghorns, 1946-47, Lots 13 to 16, are for eggs laid during the last five days of July. At this season egg shell quality is the poorest, hence any good or bad effect should have been magnified from the feeding of calcium supplements. Actually, no treatment effects were obtained. The average specific gravities do not differ significantly.

Table 4. Specific gravity of eggs laid by pullets fed oyster shells or limestone.

Lot	Supplement	Number of Eggs Tested	Specific Gravity of Eggs
	New Hampshires – 1947–48		
9	Limestone (85%)	298	1.0846
10	Limestone (85%) and Granite Grit	251	1.0837
11	Limestone (85%)	300	1.0841
12	Limestone (85%) and Granite Grit	276	1.0845
	White Leghorns – 1946–47		
13	Oyster Shells	257	1.0760
14	Limestone (90%)	255	1.0751
15	Oyster Shells	251	1.0760
16	Limestone (90%)	240	1.0772
	White Leghorns – 1947–48		
17	Oyster Shells	389	1.0874
18	Limestone (85%)	431	1.0859
19	Oyster Shells	537	1.0870
20	Limestone (85%)	576	1.0871

Eggs from both breeds were tested during the 1947-48 trials. Eggs were saved for testing during two three-day periods in April, 1948. The values were averaged and are presented in Table 4.

Comparing the Leghorns, the difference between the specific gravity values for Lots 17 and 18 is highly significant. The reason for this is not clear. It will be seen, however, that the same trend occurred between Lots 9-10 and 13-14. Apparently it was not a treatment difference but must have been caused by some error in the testing routine. As in the previous trials with Leghorns, the second pair of lots behaved alike. These results then suggest that either the 85 or the 90 per cent calcium carbonate limestone produced as good egg shell quality as did the oyster shells.

The results from the New Hampshires, 1947-48, are not presented to show an expected treatment difference, but to show that the difference between the first pair of lots is in the same direction as the first pair in each Leghorn trial. It also will be seen that the Leghorn eggs had a much higher specific gravity than the New Hampshire eggs for the year 1947-48.

Whatever the reasons for the differences, there is no evidence from this test that limestone produced an egg shell of lower density than did the oyster shells.

BONE CALCIFICATION

When this investigation on West Virginia limestone was being outlined, several members of both the feed and limestone industries wondered about the value of pulverized limestone for use in poultry mashes. Native limestone had been used for many years at the West Virginia University Poultry Farm as a calcium supplement in both chick and starting mashes. Apparently the results had always been satisfactory. When critical nutritional tests were conducted, however, oyster shell flour was used in place of the finely ground limestone. When the feeding value of the native limestone was questioned, the feeding trials reported here were planned.

The same limestones as used in the laying trials were finely ground and were compared with oyster shell flour in a chick starting ration. Chicks from a New Hampshire-Barred Rock cross were used so as to determine sex at day-old. Ten chicks were grown on each ration in each series to three weeks of age in starting batteries. At this age, five chicks of each sex from each lot were sacrificed. The middle toes of each chick were removed and ashed according to the method of Baird and co-workers in 1942.

A basal ration of the following formula was used: Yellow corn meal 37.2, ground wheat 15, ground oats 16, alfalfa meat 5, soybean oil meal 27.7, Curbay B. G. 2.5, salt – $MnSO_4$ 0.5, codliver oil conc. 0.1. The kind and amounts of calcium supplements added to this ration are shown in Table 5. Additional amounts of corn meal were added as required to make 100 parts.

The percentage of toe ash is given on a dry weight basis. These percentages are pooled values for both sexes. Results show that in both series the two sources of limestone provided as good bone calcification as did the oyster shell flour. The reason for the low calcification in Lot No. 2 of both series is not clear, unless the additional amount of oyster shell flour unbalanced the Ca:P ratio.

Table 5. Per cent of toe ash in chicks when fed oyster shell flour or pulverized limestone as calcium supplements.

	Series 1		Series 2	
Lot	Calcium Supplement	Toe Ash In Chicks	Calcium Supplement	Toe As In Chic
1	1–Oyster Shell Flour	10.68	1–Oyster Shell Flour	10.4
2	2–Oyster Shell Flour	7.92	2–Oyster Shell Flour	9.9
3	1–Limestone (85%)	10.62	2–Limestone (85%)	10.7
4	1–Limestone (90%)	11.04	2–Limestone (90%)	10.7

SUMMARY AND CONCLUSIONS

West Virginia limestone was compared with oyster shells and calcitic limestone as calcium supplements for poultry. In addition, the native limestone for use as a grit was compared with granite grit. Limestones from two different quarries were used, one containing about 85 per cent and the other about 90 per cent of calcium carbonate.

Laying trials were conducted over a three-year period. White Leghorn and/or New Hampshire pullets were used each year. The pullets were housed in a well-insulated, long-type house containing eight pens, each 20 by 20 feet. The growth trials were conducted to compare the finely ground native limestone with oyster shell flour in starting rations. The chicks were grown in batteries, and the comparison was made by the percentage of bone ash at three weeks of age.

The results for the various trials are summarized as follows:

1. Properly-sized native limestone produced just as good egg production as did the oyster shells, with the exception of the first laying trial.

2. Shells of eggs laid by pullets fed native limestones were as strong and free from rough shells as were shells of eggs laid by pullets fed the other supplements tested.

3. Native dull-gray limestones tested were consumed as readily by the layers as oyster shells and calcitic limestone.

4. Bone calcification in three weeks old chicks was comparable when starting ration was balanced for calcium with either finely ground limestone or oyster shell flour.

5. Limestone containing about 85 per cent of calcium carbonate proved to be as good, in the above respects, as the 90 per cent limestone in both growing and laying trials.

6. Additional eggs obtained from the lots fed granite grit slightly more than paid for the large amounts of grit consumed.

The results of the entire experiment seem to justify the following conclusions:

West Virginia limestone containing 85 per cent or more of calcium carbonate will, when properly sized, serve satisfactorily as a calcium supplement for growing and laying stock. A size comparable to the 2A grade is satisfactory for hopper-feeding layers. For chicks, a finely-ground material should be added to the mash.

The value of feeding granite grit with these limestones is questionable.

ACKNOWLEDGEMENT

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REFERENCES

Baird, F. D., and MacMillan, M. J., "Use of Toes Rather than Tibia in A. O. A. C. Chick Method of Vitamin D Determination." *Journal of the Association of Official Agricultural Chemists,* 25:518-542, 1942.

Waite, R. H., *Miscellaneous Studies on Poultry Grit.* Md. Agr. Exp. Sta. Bull. 377, 1935.